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ABSTRACT

This paper reviews the research literature on relationships between the integration of microcomputers and students' learning of mathematics in secondary schools. Following a brief introduction and statement of the problem, annotations are provided for 31 studies in the following subject categories: (1) the extent of computer use in secondary schools in the United States; (2) computer-assisted instruction/computer-assisted learning; (3) computer integrated instruction; (4) student attitudes; and (5) faculty and administrator attitudes. Summaries of the research in each of the five categories are provided, and conclusions and recommendations are made concerning training, administrative leadership in integrating computers into the curriculum, opportunities for students to use microcomputers, and the need for computer resource personnel and further research. (30 references) (EW)

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An Annotated Bibliography of the Literature Dealing with the Relationships between the Integration of Microcomputers and Students' Learning of Mathematics in Secondary Schools

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INTRODUCTION

SIGNIFICANCE OR JUSTIFICATION OF THE STUDY

Computer uses in instruction in the secondary schools of our nation are rising rapidly. In fact, in a survey conducted by Beck in the State of Texas, he found that over eighty-two per cent of the principals who responded to his survey reported a trend toward increasing computer usage. Less than two per cent saw computer usage on the decline (Beck, p. 9.) This survey was conducted in 1982, so the computers which were placed in the schools then have been in use now for six years assuming all units have remained operational. Thus, the logical question today is whether or not this wide-spread computer use is having a positive effect upon learning, and specifically for this project learning math, in our secondary schools.

According to a study conducted in 1980, most thirteen and seventeen year old mathematics students had received little first-hand experience using computers in the mathematics classroom (Carpenter, (1980) p. 673). Three years later the same survey was conducted and results were reported. In this report, the author stated that computers had begun to have an impact on the school curriculum (Carpenter, (1983) p. 657). The author cited evidence of improvement in basic skills which he stated could be attributed at least in part to increased computer use in mathematics classes. He then stated that the NAEP assessment indicated little, if any, improvement in mathematical reasoning skills among those thirteen year old

and seventeen year old students tested. (Carpenter, (1983) p. 659).

Today, almost a decade after the first microcomputers entered our secondary school classrooms, the use of computers as an instructional tool in secondary mathematics courses has been proven to have many positive and very few negative effects (Keuper, p. 51). Many researchers were skeptical about the use of computer assisted instruction (CAI) as reported by Signer in 1982 (Signer, (1982) p. 4). Signer expressed the same concern for the future of CAI by citing several studies in which specific problems were discussed (Signer, (1983) p. 308). However, Signer praised the future of Computer Integrated Instruction. Thus, the precise impact computers have had upon secondary school mathematics is still shrouded in a cloud of uncertainty and skepticism. The purpose of this project was to research the current literature in search of answers as to whether or not computers have had a positive effect upon student learning of secondary mathematics.

STATEMENT OF THE PROBLEM

The purpose of this research paper is to study the effect the microcomputer has had on the learning of mathematics in the secondary classroom.

PURPOSE OF THE STUDY

The purpose of this paper was to review the research literature regarding the Relationship Between the Integration of Microcomputers and the Students' Learning of Mathematics in Secondary Schools. This paper was written to provide those who read it with information on how best to take advantage of an innovative and exciting technology now available to most teachers in most schools across our country.

ORGANIZATION OF STUDY

This paper was divided into five categories. The first category examined the extent of computer use in Secondary Schools in the United States. The second reviewed Computer Assisted Instruction (CAI) also called Computer Assisted Learning (CAL). The third focused on Computer Integrated Instruction (CII). The fourth category dealt with Student Attitudes while the fifth deal with Attitudes of Faculty and Administration.

DEFINITION OF TERMS

1. Computer - "A machine, now usually electric or electronic, for the rapid solution of simple or complex calculations." Good, 124).

2. Computer - assisted instruction (CAI) "an automatic instructional technique in which automatic data processing equipment is used to present stimuli to a student." (Good, 305).

3. Computer - based instruction - a combination of computer-assisted instruction and computer-integrated instruction. (Kulik, 19).

4. Computer-integrated instruction (CII) - the use of the computer to complement the instruction by the teacher or textbook (Signer, 2).

5. Computer Literacy - implies a reasonable comprehension level about compuers and how to use them (Freedman, 63).

6. Computer program - "a group of instructions which tells the computer how to perform a specific function" (Freedman, p. 221).

7. Computer science - "The field of computer hardware and software." (Freedman, p. 64).

8. Microcomputer - "A small scale computer using a single micro-processor chip as the processor." (Freedman, p. 179).

ANNOTATIONS

I. EXTENT OF COMPUTER USE IN SECONDARY SCHOOLS

Barker, Bruce and Paul Peterson. A Research Report of Small High Schools in the United States in Regards to Curricular Offerings, Microcomputer Usage and Correspondence Courses. A Brigham Young University Report. 16 February 1984. ED 239 825. (1).

This report was the result of a survey of 475 public high schools with less than 500 students each. A questionnaire was sent to each of the high schools, and information was then collected and analyzed. Computers were used in Computer Science courses followed by Math, Business, English and Science in that order. This study indicated a growing trend toward computer usage both by teachers and by students.

Beck, John J., Jr. "Extent of Computer Usage in Secondary Schools: The Texas Story," Southwest Texas State University, San Marcos, Texas, October 1982. (Eric Document Reproduction Service No. ED 226 712). (2, 4-6, 13-14).

Beck conducted a survey of computer usage among secondary students and administrators in Texas in 1982. Results indicated that computer usage is on the rise, administrators generally were out of touch with the computer revolution, and computer usage generally increases with the size of the school campus. Cost was found to be the major reason that computer usage was not increasing at an even faster rate.

United States Department of Education. Instructional Uses of School Computers, Reports from the 1985 National Survey, June 1986. ED 274 319. (1, 11).

This survey began by listing staggering facts about the surge in numbers of computers being used in schools across the United States. The survey gathered information from more than 10,000 teachers and principals during the Spring of 1985. Even with the proliferation of computers in our schools, however, only 12% of the students nationwide used computers during an average week. The typical high school computer-using student received 90 minutes of hands-on computer time per week.

Florida Association of Educational Data Systems. A Model For Assessing and Meeting Needs in Instructional Computing: Procedures and Results of a Multi-State Needs Assessment. Appalachia Educational Laboratory, Charleston, West Virginia. ED 274 321. (2, 35, 39-42, 44).

The purpose of the program responsible for this report was to provide information to make practical the innovative ideas of the computer revolution. The Appalachia Educational Laboratory (AEL) under a contract with the National Institute for Educators did an assessment of microcomputer-related needs for the 4 states of Kentucky, Tennessee, Virgina, and West Virginia. The study lasted for six months from 1984-1985, and it compared what then existed to what was needed to affect greater learning. Once needs were surfaced, specialists in their fields were chosen to write position papers on target areas of planning and integration (Jose P. Mestec), hardware (Charles R. Sanders), Software (M. D. Roblyer) and training (John B. Cook).

M. D. Roblyer, writing about software, stated that much of the software available today is not useful to teachers or students in terms of learning objectives. Most software was drill and practice which according to Roblyer had its place but was over emphasized. Teachers wanted more simulations and subject-specific software that would tie in with state-mandated curricula. Teachers were also interested in software which could address higher level thinking skills as well as provide them with reports on student progress.

John Cook wrote about teachers and administrators that there was a real need for computer training. He stressed in-service education for teachers. He then listed several different groups of people and what they should do to cause teachers to become better prepared to teach using microcomputers.

Finally, Jose Mestec wrote about computer integration and planning. The author wrote about the expectations of CBI (computer-based instruction) and how many of those expectations never materialized. He wrote that research on CBI indicates that the effectiveness of computers as an instructional medium was more modest than anticipated. CBI accounted for only small improvements in achievements. Small attitude improvements were also reported. The gains in achievement seemed to be more apparant at the elementary level where gains of from 1 to 8 months were reportedly directly linked to CAI drill and practice of basic skills. The author related information from two separate studies, Kulik, Kulik and Cohen, and Jamison Suppes and Wells to conclude that CBI resulted in modest gains in achievement as well as reductions in the amount of time students needed for learning.

One last area of importance was the discussion of extended software packages. Normally this self-contained curriculum came with the hardware necessary to run it. Cost is prohibitive ($50,000 to $150,000) but researchers agreed that the educational benefits of such a system are outstanding. The other alternative, individual-topic packages, although not nearly as comprehensive was much more affordable. However, virtually no information was available on the effectiveness of these packages. The reason was, of course, the multitude of these products on the market.

Bonham, George W. "Computer Mania: Academe's Inadequate Response to the Implications of the New Technology," The Chronicle of Higher Education. March 30, 1983. (72).

According to Bonham, schools have raced to incorporate micro-computers into the curriculum and the long-term educational results are probably going to be minimal. He stated that the computers could have a staggering impact on learning, but as of the date of this writing the impact has been insignificant. He referred to the failure of CAI and television-aided instruction as cases to support his view. He further stated that schools have spent billions of dollars to get computers without little evidence of effective educational value. He believed we are in a "buy-first think-later" mind set.

Swadener, Marc and Jarrett, Karen. "Computer Use in Content Areas in Secondary Schools," Journal of Computers in Mathematics and Science Teaching, Winter 1986/87. (12-14)

According to the authors, computers have been placed in our schools in great numbers and this number is increasing dramatically. Computers have been used in many different ways. Among these have been CAI and word processing, programming, and discovery and problem solving. These have been the means toward achieving the goals of computer literacy, enrichment and remediation. Also, included in this particular survey was regular instruction in content areas. The authors stated that integration of the use of computers in classes, other than computer oriented classes, was also on the rise.

The authors wrote about two futures of computers in education. One was classes in which teaching the computer and its uses was the primary goal. The other was naturally integrating computers into traditional subjects as a tool. Word processing was cited as one example of a tool useful in many different subject areas. The authors indicated that it is yet unknown as to how much and how effectively CII is being used in secondary schools.

In an attempt to arrive at a partial answer to this unknown question, the authors conducted a survey. They found that most computers in secondary schools are isolated in laboratories which is not conducive to CII. Many have a small number of mobile units. One problem cited in CII was that software which was directly instructional, such as drill and practice, tutorials, and simulations were commonly used by one, two or three students. Using this software as a class required multiple hardware and software neither of which were readily available in most schools. Thus, computers are seldom used by teachers in non-computer classes in secondary schools. The authors called for school districts to have resource personnel to assist teachers in incorporating computer applications into their curriculum as a partial solution to this problem. They also called for more incentives and time for teachers to learn computer skills.

Henderson, Ronald W., Edward M. Landesman, and Iris Kachuck. "Computer-Video Instruction in Mathematics: Field Test of an Interactive Approach," Journal for Research in Mathematics Education, Vol. 16 No. 3, May 1985. (207-208).

In this research paper, the authors stated that student learning of mathematics was enhanced using the computer along with video technology to teach factoring, prime number concepts and fractions. This approach to learning served to prove that learning of math can be better achieved through computer assisted instruction (CAI). This achievement was measured both in terms of achievement and attitudes of students. Finally, the authors stressed that more research is needed as pertaining to the educational significance of what is being done in our schools using microcomputers. The authors stated that there is today little research as to how effective computers have been in our secondary classrooms.

Carpenter, Thomas P., Mary Kay Corbitt, Henry S. Kepner, Jr., Mary Montgomery Lindquist, and Robert E. Reys. "The Current Status of Computer Literacy: NAEP Results for Secondary Students." Mathematics Teacher, December 1980, 669-673. (669, 671, 673).

Carpenter et al reported findings of the National Assessment of Educational Progress in relationship to the use of computers in our nation's secondary schools. Students tested were either thirteen or seventeen years old. The author concluded that most students had little direct experience with computers in their schools.

Carpenter, Thomas P., Mary M. Lindquist, Westina Matthews, and Edward A. Silver. Results of the Third NAEP Mathematics Assessment: Secondary School." Mathematics Teacher, December 1984, 652-659 (652, 655-656, 659).

Carpenter et al reported findings of the Third National Assessment of Educational Progress in relationship to the use of computers in secondary schools. The authors found that specific skill areas had improved perhaps due in part to the rapid growth in the number of computers available to students in our schools. Problem solving, however, remained to be the area most in need of improvement. The conclusion was that only a small percentage of students were benefitting from the use of computers in their schools.

II. COMPUTER ASSISTED INSTRUCTION

Kearsley G., B. Hunder and R. J. Seidel. "Two Decades of Computer Based Instruction Projects: What Have We Learned?" T.H.E. Journal: Technological Horizons in Education, February 1983. (88, 93-94).

The authors used many different types of evaluation procedures to determine the effectiveness of computer integrated instruction. Many different projects were conducted and then summarized by the authors. CAI was evaluated as an active and promising area of computer use. The CAI uses studied were favorable because of the ability to diagnose student errors and channel students to overcome these learning deficiencies. Problems cited were cost and wider range of application. CII was mentioned as a potentially powerful adaptation to our traditional approach to teaching. In summary, Computer based instruction (CBI) was clearly proven to make instruction more effective and efficient. CBI made learning more fun, and more rewarding for both the teacher and student. The keys according to the author for the future rest in teacher training and courseware development.

Kearsley, G., B. Hunter and R. J. Seidel. "Two Decades of Computer Based Instruction Projects: What Have We Learned?" T.H.E. Journal: Technological Horizons in Education, January, 1983. (90, 95).

This article served as a separate summary of the research conducted by the authors. Nine major outcomes of CBI (computer based instruction) were identified. They were

1) evidence indicates that computers can make instruction more efficient and effective.

2) We know little about how to individualize instruction.

3) We do not have a good understanding of the effects of instructional variables.

4) A great deal has been learned in relation to resistance to change in incorporating CBI.

5) Significant progress has been made on the development of authoring tools and techniques for CBI.

6) Good procedures have been developed for evaluation of CBI ideas and courseware.

7) CBI has been the catalyst in other areas of instructional research.

8) CBI has been advanced through federal funding.

9) We have only begun to see what benefit computers can play in education.

This article concluded by describing various projects cited to provide information on CBI.

Boyd, G. M., L. Douglas, and C. Lebel. "Learner Support Options Computer-Assisted Learning," Computers and Education, Vol. 8, no. 4 1984. (349,354).

To take full advantage of computer-assisted instruction (CAI) or computer-assisted Learning (CAL) the author stated that it is important to consider group dynamics and sociostructure. The authors wrote that it is important to minimize competition. It was concluded that pairs of students working together on a common problem with a time limit did just as well as single students. This cooperative structure in the classroom worked best according to Boyd.

Evans, Peter and Rouse Martyn. "The Evaluation of a Software Package Giving Practice in Arithmetic for Children with Mild Learning Difficulties," Studies in Educational Evaluation, Vol. 11, 55-62, 1985. (55-56, 61).

Evans cited several ways in which microcomputers affected learning in the United Kingdom. The author stated that microcomputers provided the teachers with more time for creative teaching by relieving them of the tedious tasks of supervising student practice during mastery learning. Also cited was the fact that computers do not negatively effect learning because of negative interpersonal relationships between teachers and students.

The authors stated that in preparing this evaluation they could find no research reports specifying specific learning outcomes arrived at through commercially available programs. They also stated that the very criticisms raised by some researchers on the drill and practice use of computers is stated in a positive light by other researchers and little empirical evidence exists to support either view. The authors concluded their study by stating that other research indicated that CAI use of computers did enhance children's arithmetic scores.

Henderson, Peter B. "A Computer-Aided Instructional Environment," J. Educational Technology Systems, Vol. 15 (3) 1986-87. (281).

Henderson wrote that Computer-Aided Instruction (CAI) was not considered to be extremely successful in its initial applications. This was largely due to the fact that most CAI applications were simply drill and practice without any meaningful feedback. Now, however, the author stated that this feedback is becoming an integral part of many CAI packages. These new applications, the author stated, can identify certain classical errors in arithmetic for example, which will greatly increase their effectiveness in learning.

III. COMPUTER INTEGRATED INSTRUCTION

Keuper, Andra Mohr. "An Annotated Bibliography of the Effectiveness of the Computer Used as a Tool to Learn Mathematics in Secondary Schools," Indiana University of South Bend, Exit Research Project, June 3, 1985. (ERIC Document Reproduction Service Number ED 257 679). (45-46).

Keuper, by way of research for an annotated bibliography, reached some interesting conclusions based upon materials available to her in 1985. She found that mathematics instruction in the secondary schools was benefitting from the use of computers. She also reported few negative effects of computer usage. One benefit for the students, she stated, was that their learning of mathematics was enhanced by the integration of computers into the classroom as a tool with which to learn.

Signer, Barbara. "A Formative and Summative Evaluation of Computer Integrated Instruction," Paper Presented at the CBE Research Conference, 1982. (ERIC Document Reproduction Service Number Ed 224 716). (4, 10).

This paper by Signer was a report of a study conducted by the author to determine whether or not Computer Integrated Instruction enhanced student's learning of mathematics at the secondary level. The report suggested that teachers were reluctant to incorporate the computers into their curriculum. However, those who did instruct students making use of computers saw an increase in the mathematics achievement of their students when compared to the students in the control group.

The author found that CII was used so little in the classroom during the study that results of effectiveness in the classroom via computer use were difficult to obtain. Signer concluded that teachers would rather use computers with small groups as opposed to whole class demonstrations mainly due to lack of training in computer use. Because of this students were neutral toward CII. Teachers prefer CAI because it is less threatening for them and easier to implement.

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Signer, Barbara. "How the Literature and a Research Study Agree on CAI Innovation Success or Failure," School Science and Mathematics, 3 (April 1983): 307-316. (310, 314-316).

The author in this article reported on a study she conducted on the uses of computers in the State of Florida. She raised many concerns based upon her findings. She cited the failure of computer assisted instruction to live up to anticipated successes. She then made recommendations as to how best use computers as part of the existing curriculum in the future.

Signer stressed that teachers would be more willing to implement technological innovations in their classrooms if they were trained to do so and felt that these new innovations would improve learning. To incorporate computer technology, for example, because of a directive from a higher authority was not successful. Signer rather stressed the need for computer instruction to concentrate on individual teacher concerns thus requiring administration to get direct input from teachers when trying to implement new technology in school classrooms.

Molnar, Andrew R. "The Search for New Intellectual Technologies," T.H.E. Journal: Technological Horizons in Education, Vol. 10, No. 1, 1982. (104-106, 112).

Research conducted by the author indicated that computer-based instruction has had a small but significant impact on learning at the high school level. A typical student in a CII classroom scored at the 63rd percentile while a typical student in a conventional classroom scored at the 50th percentile. Computer-based teaching also had small positive effects on students' attitudes as measured by this study. Finally students receiving computer-based instruction completed learning tasks in 2/3 of the time taken by their counter parts in the traditional classroom. Other reports with the same findings were referred to by the author. Based upon these findings the author calls for drastic revision in existing curricula to incorporate available technology.

Higgo, John. David Hobbs, Wally Milner, Martin Perkins, David Tall, Joe Watson and William Wynne Willson. 132 Short Programs for Mathematics Classroom, The Mathematic Association and Stanley Thornes Publishers LTD, 1985. (5-6).

The purpose of this booklet was to provide for mathematics teachers computer programs which would allow them to integrate computers into their specific curriculum areas. This computer integrated instruction (CII) approach to learning was a goal of the authors. They state in the introduction that CAI has its place, but what is needed is for students to have meaningful contact with the computers on a regular basis. The authors wrote from the belief that students should program computers and not vice-versa (a quote from Seymour Papert).

Beach, Robert H. and Vacca, Anna M. "Administrative Variables and Microcomputer Implementation: A Survey of High School Principals," Computers in the Schools, Vol. 2(1), Spring 1985. (31-32, 44-45).

The authors stated in this article that a major issue in the coming years for school administrators will be how best to effectively implement microcomputer-based instructional programs into the curriculum of our nation's schools. Teachers now have training and schools now have computers. The question, the authors said, is how best can we use this new technology. This paper is the result of research conducted to try to determine the success of already implemented computer-related instructional programs.

The authors wrote from the premise that unless schools integrate computers into the existing curriculum the new technology will either fail or simply be viewed as a fill to use when time permits. Further, it was stated that administators are ultimately responsible for the wide-spread use of computers in their schools.

The question addressed in this paper was what factors contribute to the successful implementation of computer technology into high school instructional programs. Information on computer usage was compiled via a questionaire sent to schools in several different states. The research indicated a strong correlation between computer implementation and financial support. There was also a positive relationship between effectiveness scores of students and success in implementation of microcomputers. It was noted that successful implementation varied directly with the adaptive skills of the administrator.

IV. ATTITUDES OF STUDENTS

Carpenter, Thomas P., Mary M. Linquist, Westina Matthews, and Edward A. Silver. Results of the Third NAEP Mathematics Assessment: Secondary School." Mathematics Teacher, December 1983. 652-659. (652, 655-656, 659).

Carpenter et al reported findings of the Third National Assessment of Educational Progress in relationship to the use of computers in secondary schools. The authors found that specific skill areas had improved perhaps due in part to the rapid growth in the number of computers available to students in our schools. Problem solving, however, remained to be the area most in need of improvement. The conclusion was that only a small percentage of students were benefitting from the use of computers in their schools.

Gohs, Frank X. Individualized Study by Technology (IST). Alaska State Department of Education Report. ED 229 004 (1, 21-33).

This booklet was a summary of microcomputer usage in small Alaskan schools to allow them to offer a more complete curriculum. Alaskan history, English, reading and math were all taught using microcomputers. The program was evaluated in detail in this report. The findings indicated that both teacher and student attitudes were very positive to the program. In addition, the IST students showed significant gains in performance on the skills taught in various courses.

Brasell, Heather. Sex Difference Related to Graphing Skills in Microcomputer Based Labs. National Association of the Teachers of Science. April 1987. (1, 5).

Although one main objective of the research project was to determine sex differences in relation to graphing skills, the project also discussed the effectiveness of a microcomputer based laboratory (MBL). The MBL experience improved understanding of graphing for both males and females. It was impossible to determine who benefitted most, although females began the study with poorer graphing skills than the males in the study.

Henderson, Ronald W. and others. Theory-Based Interactive Mathematics Instruction Development and Validation of Computer-video Modules. National Science Foundation. August 1983. ED 237 327. (1).

This study focused attention on remedial work with secondary math students unable to grasp material in a traditional setting. The computer was used to teach and reteach these students. There was no control group. However, the claim was made that the computer integrated learning approach used by the respondents resulted in a beneficial effect on both affective as well as cognitive outcomes.

Dugdale, Sharon. "Pathfinder: A Microcomputer Experience in Interpreting Graphs," Journal of Educational Technology Systems, Vol. 15 (3), 1986-87. (259,261).

The author in this article described the use of a microcomputer with specific graphics software to enhance student's understanding of and skills in interpreting graphs. The students were in grades nine through twelve. Several benefits of computer usage were cited. For example, student interest in the material increased because of the motivation of the fun computer environment. With this increase in interest came an increase in understanding. Different strategies were developed by different ability-level students. This allowed this one program to address the different needs of a broad range of learning levels. The students from a variety of senior high math classes learned about graphing while at the same time had a great deal of fun.

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V. ATTITUDES OF FACULTY AND ADMINISTRATION

Signer, Barbara. "How the Literature and a Research Study Agree on CAI Innovation Success or Failure," School Science and Mathematics, 3 (April 1983): 307-316. (310-316).

The author in this article reported on a study she conducted on the uses of computers in the State of Florida. She raised many concerns based upon her findings. She cited the failure of computer assisted instruction to live up to anticipated successes. She then made recommendations as to how best use computers as part of the existing curriculum in the future.

Signer stressed that teachers would be more willing to implement technological innovations in their classrooms if they were trained to do so and felt that these new innovations would improve learning. To incorporate computer technology, for example, because of a directive from a higher authority was not successful. Signer rather stressed the need for computer instruction to concentrate on individual teacher concerns thus requiring administration to get direct input from teachers when trying to implement new technology in school classrooms.

Searle, Gary A. Microcomputer Usage in Secondary Marketing Education. A National Study. University of Wisconsin-Stout. December 6, 1986. ED 276 870 (1,4).

This report was a summary of a study conducted to determine microcomputer hardware, software and in-service training of secondary marketing programs. The conclusions were that teachers needed help in evaluating existing software. In addition to evaluation, teachers were also in need of more training, both in-service and pre-service through colleges and universities. The purpose of the report was to surface information to lead to more efficiency in the integration of computers into the secondary classroom.

United States Department of Education. Status of Instructional Technology in Higher Education, Report of Findings from the 1984-85 Higher Education Utilization Study, June 1986. ED 274 302 (III.1, IV.1).

The research summarized by this report indicated a lack of teacher preparation to face the demands placed upon them by the computer revolution. Some writers felt that this added to the criticism of education becoming mediocre. The results to many comprehensive surveys were published. Although too numerous to list the reports gave a very good picture of the current uses of computers across the nation.

Cicchelli, Terry and Richard E. Baecher. "The Use of Concerns Theory in Inservice Training for Computer Education," Computers and Education, Vol. II, no. 2, 1987. (85,92).

The authors, in this study, surveyed eighteen teachers to determine different stages of concerns regarding computer usage. This information was then used to develop a three day 15 hour inservice training module to address these concerns.

The concerns addressed in this article ranged from teacher's concern about themselves to concern about the task of implementing computers and finally concern about the impact of teaching our students. The conclusion was that as teachers' concerns are met computer effectiveness in relation to student learning would increase.

Bolton, Harold and David K. Mosow. "Microcomputers in the Classroom: A Foot in the Door." Educational Computer Magazine. September/October 1981. (34-36).

Bolton stated that computers offer great potential to effective learning in our school's classrooms, but several obstacles to this goal of effective learning needed to be overcome. For example, few teachers are trained to develop relevant materials or to use existing computer-based materials in their classrooms.

A study was undertaken by the author to determine teacher and student attitudes in relation to computer usage. Students were generally found to be more optomistic than teachers on the pre-assessment of potential learning, but teachers were more optomistic after using the computers with their students. As a result of this study, the author wrote that the literate teachers are the key to effective use of computers in the future.

Tall, David, Jim Edwards, Anne Ball, and Philip Crookall. "The Reality of the Computer in the Secondary Mathematics Classroom," Mathematics in School, January 1987. (44-45).

A survey of a sample of 52 secondary schools was conducted, and it was found that those schools had an average of 16 microcomputers per school. It was also noted that most secondary mathematics teachers do not integrate the computers into their curriculum. This is partly due to the fact that teachers are reluctant to use the new technology. One key cited by the authors is to insure that teachers are computer literate. This, the authors felt, would help overcome initial resistance to the computer. The authors concluded by stating that the advantages of computers in mathematics classrooms will not be apparent until more teachers embrace them as a means to student's learning of mathematics.

SUMMARY - EXTENT OF COMPUTER USE IN SECONDARY SCHOOLS

The first microcomputers were placed in secondary schools in the United States more than a decade ago, but only in the last few years have costs been low enough to allow widespread proliferation of microcomputers capable of using the best of the education software now available. Generally, microcomputer numbers increased with the size of the school campus (Beck). Cost was the primary reason that computer use did not spread at an even faster rate (Beck).

Computer use, at the date of this writing, was limited mostly to computer-based courses such as programming. Only 12% of the nation's students used computers during an average week at school. These students received an average of 90 minutes per week of direct computer use in 1985 (United States Department of Instruction).

Computer extended software system packages, self-contained curriculum, were proven very effective in improving student learning in several different subject areas. Cost, however, was a major drawback. An extended software package complete with hardware to run the program cost between $50,000 and $150,000. (Florida Association of Educational Data Systems).

Bonhan wrote of a "buy first, think later mentality" which he warned could cause the long-term effects of computers in schools

to be minimal. According to Beach, we have the computers, teachers have the training, but the question was how best are we to effectively use microcomputer-based instructional programs in the curricula of our nation's schools?

Of the 52 high schools surveyed by Tall, the average number of computers in 1987 per school was sixteen.

SUMMARY - COMPUTER-ASSISTED INSTRUCTION

M. D. Roblyer stated that most software in use at the time of his writing (1985) was of the drill and practice variety. Teachers were more interested in software that would tie in with state-mandated curricula. They also wanted software with diagnostic capabilities as well as software which could address higher-level thinking skills. (Florida Association of Educational Data Systems).

According to Jose Mestre, direct gains were measurable at the elementary level for programs offering training in basic skills. This was not surprising due to the repetitive nature of CAI programs and their ability to teach cognitive level thinking skills. (Florida Association of Educational Data Systems).

It was difficult to verify whether or not individual CAI type software packages enhanced effectiveness of teaching mathematics, because there were too many packages available to make in-depth effectivness testing of each one possible. The effectiveness of these individual topic packages are in direct contrast to the proven effectiveness of extended software packages several of which have been researched and proven to be very effective.

Enhanced learning of factoring, prime number concepts and fractions was verified by Ronald Henderson in his research. According to Kearsley, CAI was found to be an effective use of computers. CAI programs which can diagnose student errors were

evaluated even more positively because of their ability to channel students to specific exercises aimed at the students' areas of deficiency.

According to Boyd, group dynamics and sociostructure were important considerations in effectively using CAI in the classroom. Cooperation rather than competition was desired.

Little empirical evidence exists as to the effectiveness of CAI in public schools (Evans). This is especially true of commercially available programs.

CAI was not extremely successful initially due to limitations of the earliest programs. At the date of this writing (1987) feedback, diagnostic routines, and reporting of student progress were common functions of many CAI software packages. For example, by pinpointing a common mathematical error students were able to relearn key concepts and proceed with much greater potential for learning. (Swadener).

Finally, Signer wrote that teachers prefer CAI with small groups of students to CII with the entire class. This was the case because the teacher felt more threatened directing a whole-group learning experience.

SUMMARY - COMPUTER INTEGRATED INSTRUCTION

This research of computer integrated instruction shed light upon a relatively new trend in microcomputer usage. Computer integrated instruction is on the rise across the nation, although it is still unknown how effective this integration has been as of the date of this writing (Swadener, 1987). Kearsley calls CII a potentially powerful adaptation to our traditional approach to teaching.

Computer-based instruction expectations never materialized. Effectiveness of computers as an instructional medium was not as evident as anticipated. Gains in achievement were more dramatic at the elementary level. CBI did result in modest gains in achievement as well as reduction in the amount of time students needed for learning (Florida Association of Educational Data Systems).

Students did benefit by CII as indicated by research conducted in 1987. Students had higher achievement in math when taught using computers than those students in the control group. However, results were difficult to obtain due to teach reluctance to try CII (Kearsley).

A small, but significant, impact upon learning at the high school level due to CII was reported by Molnar. The average CII student tested at the 63rd percentile on varying achievement tests, while the aveage student in the traditional classroom tested at the 50th percentile. Students who received computer-based instruction

also reportedly completed learning tasks in 2/3rds of the time taken by their counterparts.

Beach wrote that it is up to administrators in coming years to oversee integration of computers into the existing curriculum. New technology is a frill unless it is integrated into the curriculum. What students need is meaningful contact with computers on a regular basis (Higgo).

SUMMARY - STUDENT ATTITUDE

CAI improved student attitude due to success they experienced as a direct result of using computers (Henderson, Ronald). Students attitudes were neutral in a study conducted by Signer due to lack of teacher preparation and enthusiasm. Computer-based teaching had small but measurable effects upon student attitude according to Molnar, and in the Alaskan program reported by Frank Gohs student and teacher attitudes were very positive.

Computer-assisted remedial work with secondary math students had a positive effect on student attitudes according to a study conducted by Ronald Henderson. The students were also better able to grasp material due to their working with computers. Dugdale reported similar findings in testing students' achievement in graphing skills both with and without computer assistance. Student interest in graphing was found to increase because of the motivation of the fun computer environment.

SUMMARY - FACULTY AND ADMINISTRATION ATTITUDE

According to Beck, administrators were out of touch with the computer revolution. There was a real need for computer training, in-service education and better college preparation (Florida Association of Educational Data Systems).

Another problem addressed by Swadener was that to use CAI and CII effectively requires sufficient hardware and multiple copies of software and printed material for each of the many individual packages in use. For this reason, Swadener found that computers were seldom used by non-computer teachers in public schools as of the date of his writing (1987). Swadener wrote that resource personnel were needed to assist teachers in incorporating computer applications in their curricular areas. Swadener also wrote that more incentives and time were needed as motivation for these computer-using teachers to encourage them to enhance their subject areas through the use of computers.

Ronald Henderson called for more research as pertaining to the educational effectiveness of the computers being placed in our schools. According to Henderson, little research had been done to date (1985).

According to Kearsley one key to computer effectiveness was teacher training and courseware development. Kearsley believed that computers could make instruction more efficient and effective.

Evans wrote that computers can also give teachers more time for creative teaching. But, according to Signer, teachers were reluctant to incorporate computers into their curriculum.

Based upon his research, Molnar called for a drastic revision in the existing curriculum to incorporate the available technology. Beach wrote that successful implementation of microcomputers was found to be in direct correlation to the adaptive skills of the administrators overseeing the programs. Signer called for administrators to try to get direct input from the teachers responsible for CII before mandating the implementing of new technology in the school's classrooms.

Searle wrote that teachers feel overwhelmed in the task of evaluating existing software. Searle called for in-service as well as pre-service training for teachers and administrators. According to the United States Department of Education, teachers, in general exhibited a lack of preparation to face the demands placed upon them by the computer revolution. But Cicchelli expressed his opinion that as teacher concerns are met, effectiveness of computer-assisted learning will increase. Bolton seemed to document this opinion when his research indicated that students were more optomistic than teachers prior to an initial learning experience using computers, but following the learning experience teachers were more optomistic. According to Tull, the fact is that most

secondary math teachers do not integrate computers into their curriculum because of reluctance to embrace new teachnology and lack of computer training.

CONCLUSIONS

Computer use in mathematics classrooms across the nation was proven to be on the rise due largely to the fact that there are many more computers now being placed in our secondary schools. (Beck). We have seen a trend away from traditional uses of computers for programming and literacy training to move into innovative uses such as CAI and especially CII. (United States Department of Instruction). Complete integration of computers into a specific subject seemed to be the most effective, but it was also by far the most expensive (Florida Association of Educational Data Systems). Most schools were able because of numbers of computers and available funds for software to begin using computers in all areas of their curriculum (Tall).

Computer-assisted instruction was one of the first large applications of microcomputers. There were varying reports as to the success of CAI. Most researchers agreed, however, that the newest and most innovative CAI packages, especially ones with diagnostic and report generating capabilities, were found to be effective in increasing student achievement in mathematics (Swadener). It was reported, however, that individual package effectiveness was hard to ascertain due to the impossibility of thoroughly testing each and every CAI program on the market (Evans).

Boyd pointed out that group dynamics are an important

consideration when applying CAI. But Signer wrote that most teachers tend to only use CAI with small groups of students.

The current trend in microcomputer use in mathematics classes seemed to be computer-integrated instruction (CII). Swadener reported in 1987 that although CII is on the rise across the nation, it was still too early to determine how effective this integration has been. Kearsley called CII a potentially powerful adaptation to our traditional approach to teaching.

According to research conducted by Kearsley students did benefit by CII. Students who were taught mathematics using computers had higher achievement scores than those in the control group. Results were not as conclusive as anticipated, however, due to teacher reluctance to use computers in their classrooms. Molnar also reported what was called a small but significant impact upon learning at the high school level due to CII.

Students, generally, were very optomistic about computer use in their classrooms. Many saw the computer as a means by which to overcome learning difficulties (Henderson). Dugdale reported similar findings in work done with and without compuers on graphing. Students seemed to thrive in the fun environment of computer assisted learning.

Teachers and administrators were generally viewed as reluctant to embrace the new computer technology due to lack of training, lack of time and lack of incentive (Beck, Florida Association of Educational Data Systems).

Computers were found to be used most by teachers teaching in specific computer-related areas (Swadener). Henderson pointed out that the relationship between computer use and student achievement was still unclear due to a lack of research on the educational effectiveness of microcomputers.

The responsibility for successful implementation of microcomputers was seen as the responsibility of school administrators. Signer called for Administrators to get input from teachers in implementing new and innovative programs using computers in secondary school classrooms. Beach wrote that according to his study there was a correlation between successful implementation of microcomputers and the adaptive skills of school administrators.

Searle wrote about the need to help teachers evaluate new computer software. Searle also indicated a need for increased in-service and pre-service training to help teachers and administrators overcome initial reluctance in incorporating computer use into school curriculum. As of the date of this writing teachers seemed to be especially reluctant to use microcomputers in their classrooms but Bolton offered hope when he wrote that once teachers tried to use computers in their teaching they were very positive about the effect upon student learning. Cicchelli wrote that as teacher concerns are met, effectiveness of computer-assisted learning will increase. The effect of microcomputers in mathematics classrooms will not be apparent until more teachers embrace them as an effective means to student's learning of mathematics (Tall,45).

RECOMMENDATIONS

It would be recommended that:

1) Training, incentives, and time be provided for teachers to encourage them to integrate computers into their individual classrooms.

2) Administrators give schools direction and leadership in integrating computers into the school curriculum.

3) Students be given every opportunity to increase learning through direct exposure to microcomputers and specifically to CII in each individual subject area.

4) Students be given opportunities both for remediation and enrichment using microcomputers.

5) Resource personnel be provided to assist teachers in incorporating computer applications into their curricular areas.

6) Research be done to specifically study the educational effectiveness of microcomputers in secondary schools.

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